E. M. Baker

The Monthly Review of the AMERICAN ELECTROPLATERS' SOCIETY

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SEPTEMBER 1941

The SCIENTIFIC WAY of CLEANING

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The MONTHLY REVIEW

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Editorial

Many of us who have watched the course of events in recent years are more or less concerned with the changes that are taking place in all phases of our national life. This is true of industry in general, particularly in our own line, where, in the short period of a year, we are faced with problems so complex that it seems unreal and dreamlike. These changes in which we are so keenly interested may eventually have a direct bearing on the future of the Society. The war has brought us face to face with the fact that we may never operate our finishing departments in the same manner that we have been accustomed to in the past years.

The shortage of materials because of defense priorities has changed our plating methods to such an extent that it is entirely possible we may continue to use the substitutes now being forced upon us, not only for the duration, but long after the world returns to its peacetime activities. Less nickel and heavier copper deposits seems to be the practice today. This procedure means the changing of standard formulas to conform to present emergencies and may continue to revolutionize further the methods in vogue in past years.

Many manufacturers and plating room foremen are racking their brains, wondering what finishes to use as substitutes for cadmium, brass, zinc, aluminum, etc. Some turn to plastics which are not too easy to get, because some of the materials used are also on the priorities list and even if available, are limited in their application. Others are appealing to the paint, lacquer, and enamel manufacturers to produce the finishes that will somehow give them the protection and attraction necessary to satisfy their customers for the time being at least. These groups are working with all their might to meet the need made

necessary by the scarcity of metals for plated finishes, and in most cases are doing a creditable job.

After considering these things and satisfying ourselves that we are not likely to return to normal procedures again, we venture to suggest that the scope of the Society be broadened to include the manufacturers of these substitute finishes and the men who apply them. Inviting also the makers of plastics, now that the field of electroplating is being limited. This idea is not new by any means; it has been in the minds of many members of the A.E.S. for years, the object back of it all is not so much to increase our membership, but to help the men in the finishing departments and the employers to be in a position to provide suitable finishes, when emergencies such as the present one exist.

Perhaps the time for action on the suggestion has not been opportune heretofore. Now, however, we realize that in the metal finishing field we are all dependent on each other as never before. Many men in our organization are asking if the time has not arrived when we should be designated as the American Metal Finishing Society, instead of confining ourselves strictly to the field of electroplating, for which purpose the Society was organized over a quarter of a century ago. In this connection we must acknowledge that we are using finishes other than electrodeposits in our plating departments more and more each year and that they are a very important part of the plating room routine.

SEPTEMBER IS HERE

All branch meetings of the Society will be resumed this month. We expect to have the regular reports in our hands for publication in the REVIEW by September 25, in order to be published in the October issue. Branch Secretaries please take notice and get your reports mailed in time.

COPIES OF THE 1941 CONVENTION PROCEEDINGS AND NEW BY-LAWS

The above copies will be received from our printers about September 15. New copies of the Constitution and By-Laws are being prepared and should be ready for distribution about November first.

WATERBURY BRANCH CANDEE-CRANE PARTY

We have been informed that there will be a party at the Elton Hotel in Waterbury on Saturday evening, October 25, to honor Ellsworth Candee, president of the American Electroplaters' Society and Dick Crane, chairman of the International Fellowship Club. The event will be sponsored by Waterbury Branch, of which both are members. The Branch is desirous of paying its respects to Messrs. Candee and Crane, inasmuch as this is the first time that these two important offices are being filled by men from the home city. Full details are not yet available. However, the party will be in capable hands and promises to be an enjoyable one for all who plan to attend.

Cleaning *and* Bright Plating Iron *and* Steel Parts *of* Electric Irons

*By: F. A. MAURER**
General Electric Company
Ontario, California

At the Ontario plant of General Electric Company we have been producing electric irons for over 30 years. The processing of steel and castiron parts in our Finishing Department has undergone a gradual evolution and steady growth, until last year, as an example, we plated with copper, bright nickel and chromium well over three-quarters of a million square feet of surface.

In common with others in the same business, we used to apply a very thin coat of nickel direct on steel out of a "double salts" cold nickel solution. Then came the warm "Watts" solution and much faster deposition, with resultant greater protection. The cyanide copper cleaner came about the same time; then the transition from manual operations to semi-automatic. Chrome plating in a full automatic machine came in 1931. Finally, bright nickel plating in fully automatic equipment was begun.

Our current practice in cleaning and plating must necessarily take cognizance of four main types of parts: (1) highly polished castiron bases, (2) partially polished tops, drawn from high grade No. 3 finish Cold Rolled Steel, (3) the smaller steel stampings such as handle supports, which receive a plate without preliminary polishing or burnishing, and (4) very small pieces such as screws and nuts, which are barrel nickel plated, but not chromium plated.

These parts follow various paths in their converging course toward the finishing room. Castings come in a straight line from the foundry, through five specially built Ingersoll milling machines which do all milling, drilling, tapping, and part of the polishing. The XLCR machine, next, with ten wheels in line, polishes the bottoms, with just one pass through the machine. Next, the hand operations of rounding the corners and beveling

*Engineer of Processes

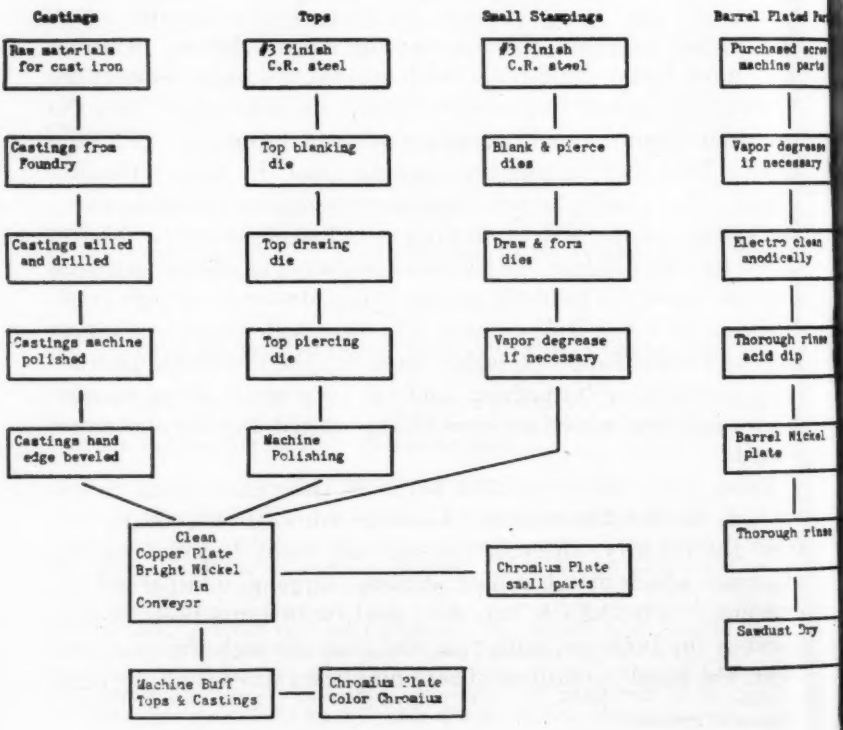
the bottom edges is done by a group of skilled polishers. The men do their own inspecting, and only a spot check of their work is made by an inspector.

Lubricants in the drilling, tapping, and polishing operations are carefully selected with the object of ready removal in the cleaning prior to plating. Either soluble oils or readily saponifiable grease such as stearic acid or tallow are used.

Tops are blanked out of #3 finish cold rolled strip steel; drawn, trimmed and holes pierced. In most dies, the light mineral oil on the steel as received is sufficient lubricant. Occasionally a saponifiable grease such as lard is used. Draw marks are left on the sides of the tops, where the stock has slid past the die. The die marks are removed by passing over two grades of built-up emery wheels — #120 and #180, on automatic polishing machine heads. Tops are placed on the polishing head, and re-

PROCESS FLOW SHEET

Chart 1.



COMPOSITIONS OF SOLUTIONS

CHART 2.

Barrel Nickel

Electrocleaner

1. Sodium Sesquisilicate 5 oz./gal.
2. Sodium Hydroxide .5 oz./gal.

Temperature 210° F.

Acid Dip

15% Hydrochloric by weight

Barrel Nickel Solution

1. Nickel Sulphate 16-20 oz./gal.
2. Ammonium Chloride 3-5
3. Boric Acid 3-5
4. pH 5.6-5.8 by glass electrode
5. Temperature 75° F.

CONVEYOR BRIGHT NICKEL — Meaker Machine

1st and 2nd Electrocleaner Anodic

1. Sodium Sesquisilicate 15 oz./gal.
2. Sodium Hydroxide 1.5 oz./gal.

Rochelle Copper

1. Metallic Copper 1.75-2.25 oz./gal.
2. Free Cyanide 1.75-2.25 " "
3. Sodium Hydroxide 6-7 " "
4. Sodium Carbonate (not over) 8 " "
5. Rochelle Salts 7-8 " "
6. Sodium Hyposulphite — trace
7. pH over 13.5

Harshaw Bright Nickel Solution

1. Nickel Sulphate 50-52 oz./gal.
2. Nickel Chloride 7.8-8.2 "
3. Boric Acid 5 -5.5 "
4. Modifying Agent .045 gal./gal.
5. Non-Pitter .0025 " "
6. Brightener .00025 " "
7. pH 3.0 Electrometric
8. Temperature 130°F.

Hydrochloric Acid Dip

15% Hydrochloric by weight

Sulphuric Acid Dip

40% Sulphuric by weight

CONVEYOR CHROMIUM — U.S. Galvanizing Machine

Electrocleaner Cathodic

Sodium Carbonate 2 oz./gal.

Chromium

1. Chromic Acid 46-52 oz./gal.
2. Sulphuric Acid .66-.77 oz./gal.
3. Ratio CrO/H SO 66-76

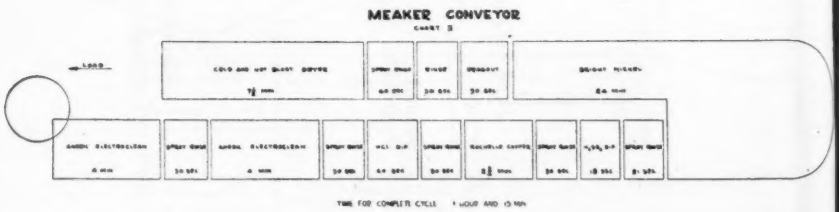
Solution

4. Iron 0.20 oz./gal.
5. Trivalent Chromium 0.12 oz./gal.

moved by an operator who feeds two such #120 heads and two #180 heads. Tops are held against the rotating wheel while they themselves are being rotated with the polishing grain — that is, work goes down with the wheel — and at the same time an oscillating motion is imparted to the polishing wheel. A narrow band about one inch wide is polished, from the bottom edge up. No hand finishing is necessary, and no polishing is done on the upper portion of tops.

Small steel stampings for duty on exterior surfaces are as a rule handled direct from the press room. There is ordinarily just a light coating of mineral oil on these parts, which the alkali cleaners can successfully remove. However, in some cases of punching heavy gauge stock, a heavy sulphurized oil must be used to keep the cutting edge of the die from breaking down. We have found it advisable to clean such parts in a solvent vapor degreaser prior to putting through the regular cleaning and plating process.

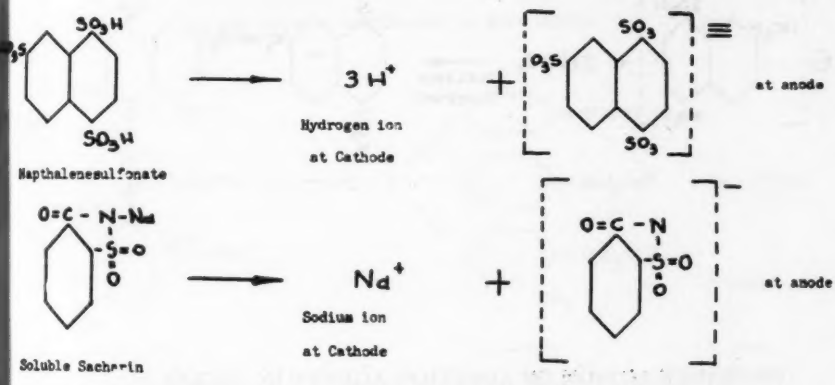
The fourth general class of parts we put an electroplate on are small steel stampings for duty on the interior of the iron, and bolts, nuts and screw machine parts. Interior parts get a protective coat of grey nickel, in a barrel set-up. Certain parts for exterior duty are barrel plated, using a proprietary brightening agent in the barrel. Many of these parts have a coating of heavy sulphurized oil and must be degreased before going to the alkali cleaner. All small parts to be barrel plated are first cleaned anodically for fifteen minutes in an electrocleaner composed of five ounces sodium sesquisilicate and 0.5 ounce caustic soda, operated at boiling temperature. After a very thorough rinsing they are dipped in 15% hydrochloric acid, rinsed and emptied into the plating barrels for a two to three hour plate. Barrel solutions are operated at pH 5.6 to 5.8 by glass electrode; nickel sulphate 16 to 20 ounces per gallon, ammonium chloride 3 to 5



ounces per gallon, boric acid 3 to 5 ounces per gallon. The solution running highest in solids content contains the brightener and is used for plating the exterior parts.

All parts other than those barrel plated are cleaned and plated in the fully automatic Meaker conveyor. Chart 3 shows a diagram of the floor plan arrangement. There are now fifteen tanks in the arrangement, two more than last year, because of addition of another electrocleaner and rinse. The addition of the second cleaner made the operation very much easier to keep free of oil and grease; I believe I can say the most critical tank from the grease standpoint is the sulphuric dip after copper plating. Perhaps that is because this dip will expose any faults of previous treatments. For instance, grease in tanks ahead of copper will be knocked off by the strong cleaning effect of the copper solution, and will accumulate in the solution as soaps or emulsified mineral oils. If not very completely removed from work surface by rinsing, such soaps and emulsions will be released as free fats and oils in the sulphuric acid dip and are quite prone to draw together into tiny circular areas on the copper surface, due to

IMPROBABLE ACTION OF ADDITION AGENTS IN NICKEL SOLUTION Chart 4.



IMPROBABLE ACTION OF ADDITION AGENTS IN NICKEL SOLUTION

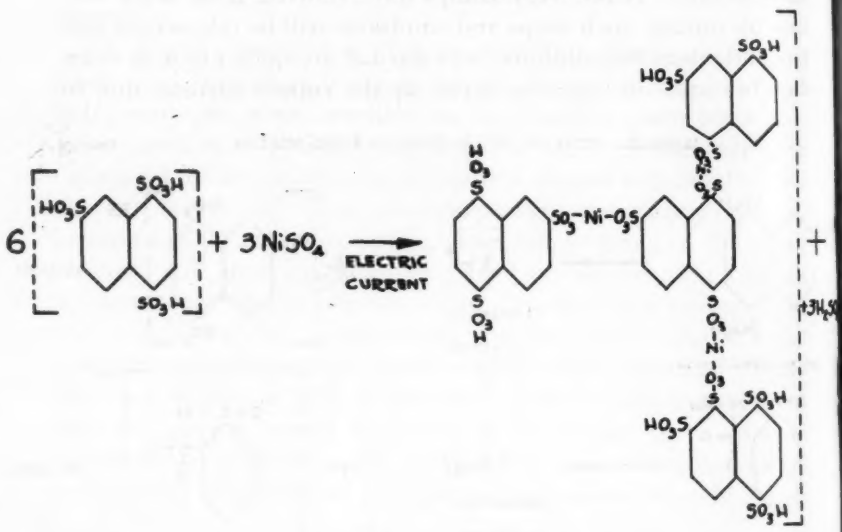
Explanation above would assume the modifiers or semi-brighteners behave the same as salts in solution, breaking up into ions which migrate to anode and cathode.

It is improbable that this is what actually takes place, because there would be a tendency to deplete the cathode region of the organic substance. To influence the plate, the organic radicle should be concentrated at the cathode.

surface tension effect. Wherever such areas of grease occur, there will be no plate. This phenomenon is similar to what has always taken place in dull nickel with oil droplets on the work and is what we used to call grease pitting. However, the trouble is much more pronounced in bright nickel because the droplets of grease tend to be absorbed by the solution, due to its low surface tension. In dull nickel the solution exerted a prying off effect on the droplets, in many cases sufficient to remove the grease and permit plating.

It must not be inferred from the foregoing that the operation is causing us enormous losses in rework. Quite the contrary — we are justifiably proud of the low ratio of rework losses to volume of output. During the past three months, by way of illustration, the losses chargeable to nickel plating have averaged about 1.5%

PROBABLE ACTION OF ADDITION AGENTS IN NICKEL SOLUTION Chart 5.



PROBABLE ACTION OF ADDITION AGENTS IN NICKEL SOLUTION

This is an attempt to show how sulphonated napthalene in nickel solution can combine its molecules together to form huge particles of colloidal proportions. It is evident the diagram above shows just the starting of the process, since it can be repeated at each hydrogen atom, and molecules of the order of 50,000 molecular weight produced.

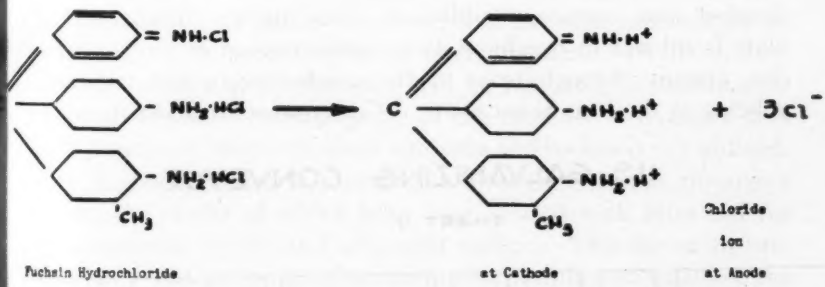
Such colloidal molecules adsorb an electric charge which helps propel them to the work surface where they influence the character of the plate. The charge is readily given up and probably no change in the structure of the colloid results.

of the production. Poor cleaning was responsible for only one-quarter of this. Defective chromium plate on the nickel during the same period of time averaged about 0.75%. This good record is largely the result of close attention to all operating details by Mr. Weber, foreman, and Mr. Extale, analyst and control chemist.

Now, a word on the individual solutions. The sequence of treatments, and time in each is as shown on Chart 3. In all water rinse tanks, a gentle flow of fresh water is maintained, from bottom to top. They are all equipped with sprays which hit the work entering and leaving the tank. The valves are automatically operated electrically. Both electroclean solutions are of the same strength, 6-7 ounces sodium oxide per gallon, which is derived from 15 ounces sodium sesquisilicate and 1.5 ounces caustic soda per gallon. We have found the anodic cleaning best suited — a film is usually left on castiron when cleaned cathodically. Laboratory check and additions are made daily. Current density of 80-100 amperes per square foot are used.

The acid dips are checked and additions made daily. Hydrochloric standard is 15% by weight, and sulphuric 40%. Action of hydrochloric acid on steel is unnoticeable; castings retain

PROBABLE ACTION OF ADDITION AGENTS IN NICKEL SOLUTION Chart 6.



PROBABLE ACTION OF ADDITON AGENTS IN NICKEL SOLUTION

This explanation of the probable action of the extreme brighteners of which Fuchsin is an example seems reasonable.

It is known that compounds of this type, in weak acid solution such as nickel are strongly polar, and split into ions.

It is known that this compound is consumed in proportion to the amount of current passed. Therefore the compound either becomes a part of the plate, or perhaps more probably is destroyed or changed in properties at the work surface.

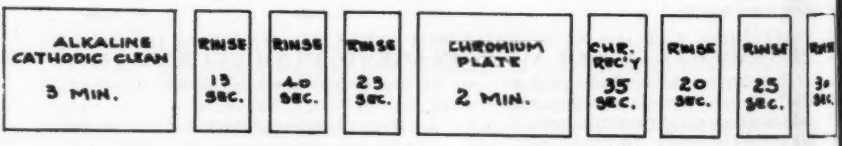
some heat from the cleaner and there is noticeable gassing, but no real pitting of the surface. It has been found that 40% sulphuric is needed to completely neutralize the cyanide film on the copper and obtain proper adherence of bright nickel.

Copper solution is checked for metal, free cyanide, caustic soda and Rochelle salts, and additions made daily. This we have found more difficult to keep operating properly than the nickel. When it is realized that this solution is operated relatively hot, at 150°, and is 700 gallons only, and cyanide is constantly decomposing, it is seen that changes in conditions are greater than in the relatively stable nickel solution of 4,000 gallons operations at 130°. We have found addition of a very small amount — hardly more than a trace — of sodium hyposulphite to be helpful in maintaining a bright plate. We also believe in keeping free cyanide high, and our sodium hydroxide content of 6-7 ounces per gallon brands this more as a cleaning solution than a copper plate. What we obtain in the tank is good thorough cleaning action, with a flash of copper on to prove that the surface is clean. Current densities in the range of 30-50 amperes per square foot are used.

The nickel sulphate, boric acid, and nickel chloride content of the bright nickel tank are checked and additions made once a week. The organic materials present: surface tension reducer, brightener, and the modifier or carrier for the brightener are checked and necessary additions made daily. Bright nickel plate is subject to roughness from anode carbon or metal particles, coming through tears in the anode covers and constant policing of the bags is necessary. Continuous filtration through

U.S. GALVANIZING CONVEYOR

CHART 7



RETURN IS OVERHEAD THRU HEATED TUNNEL

TIME FOR COMPLETE CYCLE - 25 MIN.

filter paper backed by canvas cloths in a rubber covered shriver filter press helps to keep rough particles out and maintain a crystal clarity of the plating solution.

Since the ductility of the plate and susceptibility to double plating of nickle are influenced by brightener content, we maintain as low a level of brightener as will give us required lustre. On small, unburnished, unpolished stampings, the #3 finish is so good that the low level of brightener still gives good lustre. On polished tops and castings, the polish marks showing make necessary a cut-down buffing, and ductility is far more important than extreme lustre. We insure uniform flow of current to the parts by a spring contact between rack and carrier arm, and carrier arm and current bus bar and a once serious peeling of nickel off nickel is now practically unheard of.

Extreme care is exercised to prevent stray currents through the lead heating coil. When a lead surface in bright nickel becomes anodic it seems to provide ideal conditions for decomposition or oxidation of the surface tension reducer and the brightener. At times when our lead coil became anodic, a very marked increase in consumption of these organic materials was noticeable. At the same time, a smoky tone developed on the nickel plate instead of the usual clear lustre.

The standard method of ridding a nickel solution of waste organic products and oil or grease is to treat with activated carbon. If sufficient carbon is stirred into the solution, usually in a tank separate from the plating tank, practically all the surface tension reducer and brightener will be removed, in addition to waste products. Perhaps some of the modifier is removed but it is present in relatively large amounts and its loss is not noticed.

It is good practice to periodically filter the solution, through a press, the cloths of which have been coated with filter aid (or diatomaceous earth) and activated carbon. This serves to prevent any accumulation of waste products sufficient to affect the plate, and takes out oils or fats held in emulsion form by the surface tension reducer.

It is of interest to speculate on what the mechanism of bright nickel plating really is. We are reasonably sure that the crystals of bright nickel are kept extremely small and of uniform size; and furthermore that they are made to develop on the surface in a definite orientation, that is, they are "made to lie down flat in-

stead of standing up." It has been suggested that the nickel crystals may be kept under 0.0001 of a millimeter by the use of a material such as nickel napthalene trisulphonate, which mechanically prevents formation of large crystals because its large molecule becomes adsorbed on the nickel deposit.

It is claimed that mutually beneficial effects are obtained in bright nickel by the use of a "modifier" and a "brightener." The modifier is of the class of compounds mentioned previously — namely a sulphonated napthalene, or it may be derived from benzene, and belong to the class known as "sulphonamides," and "sulphonimides," of which saccharin is an example. These regulating agents are said to exert a ductilizing effect on the plate and plating experience appears to bear this out. The compounds listed as brighteners cause extreme lustre on the plate, and also are the cause of brittleness when used in excess. When this, the extreme potency as well as singular effect of the brightener, is recognized, little trouble with brittle plate is experienced. The brighteners belong to what are known as the triphenyl-methane dyes — one of which is fuchsin, or a derivative thereof. The surface tension reducer may be sodium lauryl sulphate.

It will be of interest to consider possible reactions of the organic compounds in bright nickel. One explanation is as follows. The sulphonated napthalenes are polar compounds — that is they can dissociate or separate in solution into "ions," one being hydrogen and the other the napthalene molecule with addition of the sulphonic radicles. This large structure, of molecular weight 207 might be borne by the current to the anode whereas the hydrogen goes to the cathode or work surface. However, an explanation such as this does not seem very valid, because the passage of current would tend to deplete the cathode region of the regulating agent, and its effect on the character of the plate — an effect which is dependent upon its presence at the immediate surface — would become less and less with passage of more and more current.

A more probable explanation is that the molecules of the sulphonated napthalenes combine into very large aggregates. When poly sulphonated napthalenes are present in solution, the extent of such aggregation of simple molecules is almost unlimited, so that huge structures of the order of 50,000 molecular weight may be built up. The chemistry of such huge molecules is different

from that of ordinary sized molecules. They are in the collodial class of materials — familiar colloids are gelatin and glue. Particles of colloids are capable of picking up charges of electricity without being altered in their structure. The electric charge is simply superimposed on the original structure. When ordinary compounds in solution split into ions, there is an actual separation of the molecule, each portion of which then bears an electric charge sufficient to exactly neutralize the charge of opposite sign on the other portion.

The electric charge is instrumental in propelling the large colloid particle to the immediate vicinity of the electrode. Thus in the case of the sulphonated napthalenes, what probably takes place is that the colloid particle picks up a positive charge which helps to propel the particle toward the cathode and keep it concentrated in the immediate vicinity. When the colloidal particles are present at the actual surface where metal is being plated out of a solution they seem to prevent the growth of large crystals. Also, there is reason to believe that certain compounds cause orientation of the crystals in definite planes. The reflectivity of the surface is much higher, since there is no disordered jumble of crystals to break up the light waves.

Probably the colloids are not deposited from solution, although several investigators claim to have found traces of sulphur compounds in bright nickel plate. Such traces may have been mechanically caught during the process of deposition. The electric charges which the colloid particles bear on their journey toward the cathode are given up at the work surface, probably without causing any change in structure.

The triphenylmethane dye type of brightener on the other hand is consumed in direct proportion to the concentration of it in the solution and the amount of current passed. This is because the compound splits up into ionic chlorine which migrates to the anode, and the large organic dye molecule — of weight around 300 which migrates to the cathode. Whether this complex actually plates out with nickel and becomes integral with the plate or is merely concentrated in the cathode film is not for us to say. It would seem however that the extreme brighteners owe their effectiveness to this property of being concentrated at the cathode surface. The fact that these brighteners have to be added regularly in greater quantity than

could be accounted for by drag-out means they are actually plated out, or changed by the plating process to ineffective compounds.

The amounts of these materials that are needed to plate nickel bright are extremely small. In a bath containing 32 ounces per gallon of nickel sulphate, 5 ounces boric acid, and 5 ounces nickel chloride, for example, only 0.033 ounces of the surface tension reducer sodium lauryl sulphate, 0.53 ounces of the modifier, nickel napthalene sulphonate, and 0.00067 ounces of the brightener, reduced fuchsin, need be present.

So much for nickel plating. Steel tops and castiron bases go from plating to automatic buffing equipment where a high polish is put on. After an auxiliary color buffing, parts go to the chromium plating section, where they are racked on a separate conveyor. As the loaded racks are brought up to the plating machine, they are transferred manually.

A 2 ounce per gallon solution of sodium carbonate is used to clean the parts, cathodically, at 120° F. No acid dip is used, ahead of chromium, though provision had been made for one; consequently we have three water rinses after the cleaning. Chromium plating is for two minutes in a solution carrying, per gallon, 52 ounces chromic acid, 0.77 ounces of sulphuric acid, ratio chromic to sulphuric acids 0.67. In a typical analysis the iron ran 0.20 ounces and the trivalent chromium 0.12 ounces per gallon. Current density is around 225 amperes per square foot. The usually recommended ratio of 100 to 1 does not work with us because nickel is passive, there being no acid dip before chromium plating. Plating of excellent brilliance and good coverage is obtained by this system. Defective chrome, due to whatever cause, is currently running only about 0.75%.

Steel tops and castings are color buffed after the plating, usually only to remove chrome stains and water marks. We have found this method better than any other attempted. Unbuffed chrome retains finger marks which seem to "burn in" when the irons gets hot on test. Buffing the surface prevents this, so that on the final cleaning wheel just before packing out, finger marks come off easily.

Even though extra money is paid for plating nickel bright, and and then a large part of the production is buffed, we have found this a more economical system than buffing dull nickel, due to

savings in buffs and compound. Bright plated small parts not buffed have a very superior appearance over the old dull nickel, burnished.

This paper was written and read before the Los Angeles Branch of A.E.S. before the shortage of nickel for defense purposes caused the restriction of its use in electroplating. Our practice has, therefore, been modified to conserve nickel, without reducing corrosion resistance or appreciably affecting appearance. This result can be accomplished in two ways, both of which are employed on our several parts.

First, the parts, made of either steel or cast iron, are much more highly finished prior to applying nickel, thereby requiring very little cut-down buffing of the nickel. In other words, what nickel is applied is left on the part, doing little more than color buffing before applying the chrome plate. Secondly, the parts, whether steel or cast iron, may be less highly polished, first applying heavy copper which is cut-down buffed and color buffed, and a very thin coat of nickel applied. Parts are again color buffed before chrome plating.

We use both methods, even though the cost is somewhat higher, in order to spread our supply of nickel, under the Defense Program, over a larger number of appliances. The paper is still applicable as describing methods for cleaning iron and steel parts and putting a copper, bright nickel, and chromium coating on.

BRANCH EDUCATIONAL PROGRAMS

Librarians are now completing arrangements for their fall and winter educational programs. While it has been more difficult to find speakers who can devote their time and effort to our educational programs, we have nevertheless been able to furnish two lists to all librarians and will have a considerable number of additions in the near future. Generally speaking, the qualifications of those who have signified their availability for this season are exceptionally high. We feel very well pleased about this and sincerely hope that all branches will avail themselves of a full quota of these outstanding speakers for this season.

In addition to speakers, we have been able to secure a great many moving pictures, both sound and silent, some in technicolor and some in black and white, covering many subjects ranging through mining, geology, steel, chemistry, electroplating, and other subjects. We recommend that librarians consider a moving picture for part of each educational program. Lists of these films have been sent to all librarians. For variety, we have found that some branches had some highly instructive and entertaining sessions last year, by staging a type of "Information Please" program. We recommend this for your consideration this season. This can be done by drafting several of your Branch members for the master minds or by importing outside talent.

Good attendance at meetings can be secured in strenuous times like these only by providing programs with sufficient appeal. Fellowship should be stressed. Refreshments help tremendously and a committee whose duties are to see that everybody is acquainted and made to feel at home, should function at every meeting. An excellent plan for librarians to follow in making up programs is to discuss those available with the branch at an early meeting. If everyone has a part in planning them, interest will be greater. We urge that programs be arranged early. If the type of program your branch wants is not available, write your supreme educational chairman. He'll do all he can to help you find it.

CHARLES C. CONLEY, Chairman, Educational Committee

Supplies and Defense

By W. D. STARR
The Lea Mfg. Co.,
Waterbury, Conn.

August has been a big month for new development in Defense Supplies.

A reorganization of Defense agencies places a seven man Supply and Priority Board in charge of all Priorities and allocations, including Civilian. This apparently centralizes authority which was formerly shared to some extent with OPACS (now OPA). Donald M. Nelson is the new director of the OPM Priorities Division, replacing E. R. Stettinius, Jr. The entire move is calculated to accelerate conversion of civilian industry to military needs.

The Defense Supplies Rating Plan is in full swing with firms analyzing for percentage Defense sales on a monthly basis instead of quarterly as reported in the August issue. "Affidavit form PD-25-C was replaced with Certificate form PD-25-C on August 15th. The new form makes it clear that percentage Defense Sales rather than Purchases are to be reported."

Here is a round-up of some supplies which are affected by recent regulations:

Steel was placed under full Priority control effective September 1, and that will affect deliveries of plating equipment, also supplies packed in steel containers.

Chlorine is on Priority and we begin to feel the effects in Trichlorethylene deliveries. Users are being questioned as to needs for Defense.

Tin is still plentiful at this writing with price control measures in effect. Supply problem is one of shipping.

Copper is under more rigid control to insure adequate Defense supplies.

Formaldehyde and kindred chemicals are under rigid control which extends to plastics made with same.

Peroxide is hard to get without Priorities.

Zinc, Cadmium, and Nickel including their chemicals, are same as last reported.

Chromic Acid Baths *for* Anodizing *or* Chromatizing Aluminum *or its* Alloys

Read before Los Angeles Branch
June 11, 1941.

By MANUEL SANZ

Staff, University of Southern California, presently associated with Process Engineering group, Vultee Aircraft, Inc.

THE chemical control of the sulphuric acid process electrolyte for anodizing is relatively simple. However, in chromic acid anodizing baths, the chromic acid is capable of entering into combinations forming various complex compounds, and the analysis of the solution becomes more difficult. Previous investigations on anodizing in the chromic acid electrolyte have been carried out on a laboratory scale with solutions ranging from 3 to 10% of chromic acid by weight;[8, 9] but in no case has the original concentration of free chromic acid been maintained at a constant value for the entire life of the bath. It is my belief that the variable introduced by the transformation of free chromic acid to chromates, bichromates, and trivalent chromium salts should be better understood and controlled. At least, the free chromic acid concentration should be maintained at a constant value for the life of the bath.

Definition of Anodizing and Anodizing Requirements for Aircraft

When aluminum is made the anode or positive electrode in certain electrolytes, an oxide film is formed on its surface. This process is known as anodizing. The aluminum oxide film, ranging in thickness from one-half millionth to eight hundred millionths of an inch[1, 2, 3] has many desirable properties, the most important, as far as the aircraft industry is concerned, being its high resistance to abrasion and the adherence offered for paint.[4]

The latter property makes the combined anodic and paint finish the most desirable treatment for aluminum from the standpoint of corrosion resistance. For this reason, it is required by specification on all surfaces exposed to atmospheric corrosion on naval aircraft.[5] Less severe weathering conditions on

army[6] and commercial land planes require anodizing on a smaller number of parts. Of the various electrolytes in use, such as sulphuric acid, oxalic acid and chromic acid, the chromic acid has been adopted by all or the majority of aircraft companies operating in the United States.

Chromic Acid Process

The process as it is used at present is described in the Army Air Corps Specification 98-20005-B and, briefly, consists of immersing the cleaned aluminum parts in a solution of 5 to 10% chromic acid (CrO_3) by weight, at a temperature of 95° F. plus or minus 4° for a period of 30 minutes at a potential of 40 volts, the aluminum being the anode or positive electrode and the steel tank the cathode during the electrolysis. This specification has been superseded by Specification AN-QQ-A-696[7] which only requires that specimens anodized withstand the salt spray test [10, 11] for at least 720 hours and allows the contractor a free hand in the development of his own process and gives him the choice of either sulphuric acid or chromic acid for the electrolyte.

The Army Specification 98-20005-B contained a paragraph which called for the addition of chromic acid to maintain the required concentration due to dragout losses. No method for the analysis of the electrolyte and no recommendation for the anode to cathode ratio (ratio of surface of the work to the inside surface of the tank) was prescribed. These two factors are very important variables and explain why anodized specimens from various aircraft factories did not always pass the salt spray corrosion test called for by the specification, although seemingly operating under the same conditions.

Anode to Cathode Ratio

R. W. Buzzard and J. H. Wilson[8] have shown that the reduction of the chromic acid in the electrolyte is affected by the anode-cathode ratio, less chromic acid being reduced at higher ratio values. In plant practice, when the anode loads or the work in the tank varies from load to load and from plant to plant depending upon the habits of the operator and the type of clamps used, the operator using heavier loads will find that he can get better results operating under lower concentrations of actual or free chromic acid, and even obtain satisfactory results when the acid concentration is below 2%, than an operator anodizing with

the same concentration of chromic acid in solution when employing lighter loads. Also, the operator who is using heavier loads will find that less chromic acid additions are required during continuous operation of his tank.

The above is due to the fact that chemical equilibrium of the electrolyte is altered, a greater anode or oxidizing area having a reversible effect on the electrolyte as shown by the following equation: $8\,CrO_3 \rightleftharpoons Cr_2(Cr_2O_7)_3 + 3\,O$. A smaller anode surface has the opposite effect, that of making the reaction go to the right and robbing the solution of chromic acid which Buzzard and Wilson of the Bureau of Standards hold responsible for the anodizing action.[8]

To obtain uniform operation, the chromic acid content must be kept constant. This requires a simple and reliable method of analysis. The pH method which is proposed by Buzzard and Wilson[8] has not proved satisfactory in plant operation, nor have the more difficult iodometric and ferrous ammonium sulphate oxidation methods. The latter two require an additional aluminum determination in order to arrive at an approximate chromic acid content. The method which I hereby propose is simple and reliable.

Analysis of Chromic Acid (Anodizing and Chromatizing Solutions)

Reagents

1. Standard sodium hydroixde (about 1 N. NaOH)

Special Apparatus

1. pH meter (glass electrode)

Procedure

1. Pipette 25 ml. of the solution into a 250 ml. beaker and dilute with water to 100 ml.
2. Stirring continuously, titrate the solution using the Beckman pH meter and record the mls. of NaOH solution required to bring the solution to pH 3.2, pH 4.8 and pH 9.0. The NaOH solution should be added cautiously in the region of the desired pH, since a very small addition will cause a large increase of pH values at these points.

Calculations

Let A = ml. of NaOH solution to pH 3.2
B = ml. of NaOH solution to pH 4.8

N = normality of NaOH solution

1. $\frac{\text{Chromic Acid } (CrO_3)}{AN\ (0.4) = \text{gm./100 ml. of } CrO_3}$

2. $\frac{\text{Alumina } (Al_2O_3)}{BN\ (0.68) - AN(0.694) = \text{gm./100 ml. of } Al_2O_3}$

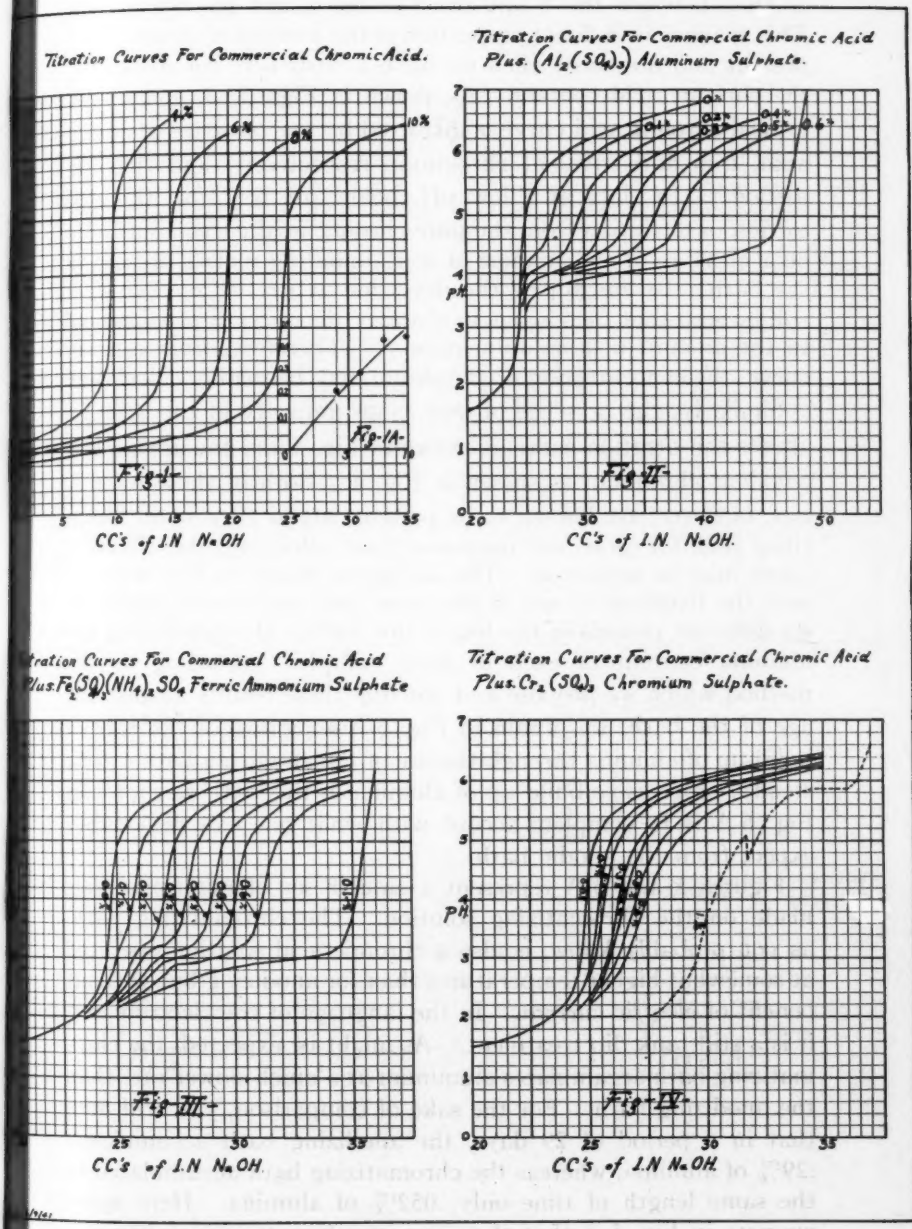
3. $\frac{\text{Total Hexavalent Chromium } (CrO_3)}{BN\ (0.4) = \text{gm./100 ml. of total } CrO_3}$

A spectrographic analysis of a typical anodizing solution about one month old, run by courtesy of G. L. Cheney, Chief Chemist, of the Smith-Emery Company, is shown as follows:

Chromium (Cr)	major constituent (dry basis)
Aluminum (Al)	5.0 %
Calcium (Ca)	0.5
Silicon (Si)	0.1
Magnesium (Mg)	0.1
Copper (Cu)	0.1
Sodium (Na)	0.01
Sodium (Na)	0.01
Iron (Fe)	0.01
Manganese (Mn)	0.01
Strontium (Sr)	0.001

As can readily be seen from the analysis, the major contaminating element in the anodizing solution is aluminum. An impurity such as iron, which would interfere with our method of analysis in the alumina determination, is shown to exist in very small concentration (.01%) as compared with 5% for aluminum. It is for this reason that we may, without appreciable error, report our results as aluminum. With the collaboration of Harold Schiller and E. R. Holman, courtesy of Turco Products, Inc., an investigation was made into the influence on the titration of chromic acid of the three most probable contaminants: aluminum, iron, and trivalent chromium.

As a chromic acid solution is progressively neutralized, the pH rises according to the curves shown in Fig. 1. These curves represent a known concentration of 4%, 6%, 8%, and 10% solutions of chromic acid, respectively. You will note at once that the space between the 8 and the 10% curves is exactly the same


Titration Curves For Commercial Chromic Acid.
4%
6%
8%
10%
Fig-IA-
Fig-I-
5 10 15 20 25 30 35
CC's of 1.N NaOH
Titration Curves For Commercial Chromic Acid
Plus. $(Al_2(SO_4)_3)$ Aluminum Sulphate.
0.1%
0.2%
0.3%
0.4%
0.5%
0.6%
PH
Fig-II-
20 30 40 50
CC's of 1.N. NaOH.
ration Curves For Commerial Chromic Acid
lus. $Fe_2(SO_4)_3(NH_4)_2SO_4$ Ferric Ammonium Sulphate
Fig-III-
25 30 35
CC's of 1.N NaOH.
Titration Curves For Commercial Chromic Acid
Plus. $Cr_2(SO_4)_3$ Chromium Sulphate.
PH
Fig-IV-
20 25 30 35
CC's of 1.N NaOH.

as that between the 6 and the 8 or the 4 and the 6% curves. This spacing is in direct proportion to the amount of chromic acid present and obviously then we have a basis here for measuring the chromic acid content. As shown in Figs. 2, 3, and 4, this typical chromic acid curve is distorted by the presence of aluminum, iron and trivalent chromium, respectively, and this distortion takes place at a low pH, below pH 6. Now this distortion or deviation from the pure chromic acid curve appears to be a measure of the amount of contaminating metals present in the bath. By measuring the deviation at pH 4.8 on Fig. 2, it will be seen that the change in shape of the curve is proportional to the amount of aluminum present. Therefore, from a given curve, the concentration of aluminum may be readily calculated.

Similarly, the presence of iron as an impurity in the solution affects the titration curve as shown in Fig. 3 and the presence of trivalent chromium as shown in Fig. 4. Both of these impurities, however, are known to be present but in very small quantities and for practical purposes their effect on the titration curve may be neglected. The six curves shown in Fig. 6 represent the titration curves of the same bath on samples taken at six different periods in the life of this bath. By calculating the alumina content of each of these samples, according to the method which we propose and plotting these results against the age of the bath, we obtain in Fig. 6-A a picture of the rate of build-up of alumina through the use of the anodizing bath. The steady, progressive build-up of alumina in this bath as shown in Fig. 6-A is in complete accord with what one can reasonably expect from the anodic bath.

Figures 5 and 5-A represent a similar set of determinations made on the chromatizing solution. The chromatizing bath, as you probably know, is also a chromic acid solution operated at somewhat higher temperatures than for anodizing but without benefit of electric current. In the language of the electroplater, it is a still tank dip treatment. As might be expected, the chromatizing bath accumulates aluminum at a much slower rate than the anodizing bath. For the sake of comparison, you will note that in a period of 29 days, the anodizing bath accumulated .29% of alumina, whereas the chromatizing bath accumulated in the same length of time only .052% of alumina. Here again we note in Fig. 5-A that there is a steady, progressive increase

Titration Curves of a Chromatizing Bath Over a Period of One Month. (Non-Electrolytic)

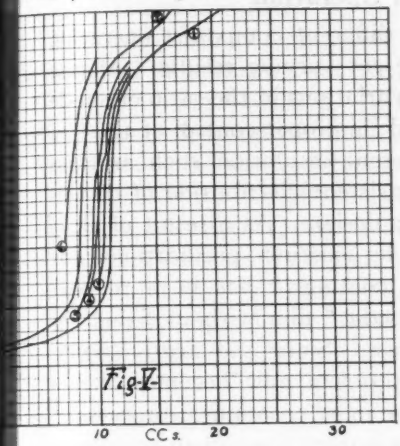


Fig-V-

① Original Solution
② After 7 Days
③ " 9 "
④ " 15 "
⑤ " 22 "
⑥ " 29 "

Titration Curves of an Anodizing Bath Over a Period of One Month. (Electrolytic)

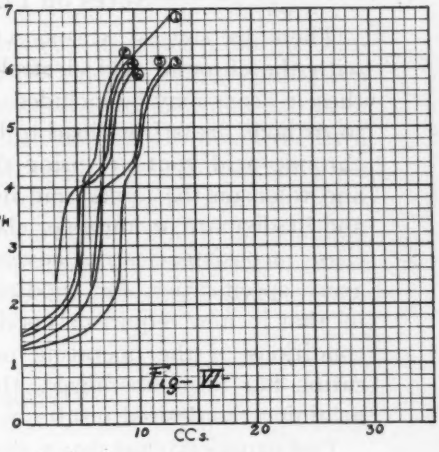


Fig-VI-

① Original Solution.
② After 7 Days
③ " 9 "
④ " 15 "
⑤ " 22 "
⑥ " 29 "

Increase of Contamination of Chromatizing Bath With Use.

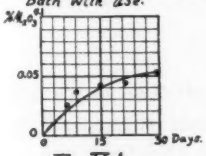


Fig-V-A

Increase of Contamination of Anodizing Bath With Use.

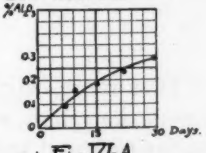


Fig-VI-A.

6/9/41

in alumina content and that the rate of increase is similar to that obtained in an anodizing bath on a much slower scale.

In summarizing the work illustrated in these graphs, we can say that we have developed a simple, rapid, reliable method for testing anodizing or chromatizing solutions, not only for their free chromic acid content, but also for the contaminating alumina content.

Notes on Plant Operation

There are several reasons why different companies operating with the chromic acid electrolyte get varying results. Among these reasons may be included: Variations in the ratio of anode to cathode areas from load to load; improper control of the free chromic acid content; using different insulation such as glass and wood on the tanks; and inconsistent distribution of clamps and inadequate or improper clamp design. As a result of all of these inconsistencies not covered by existing specifications, the army specification for anodizing coatings [6] has been revised, in that it now requires a good anodic [7] film without fixing the conditions of the operating process. Since the army specification has been liberalized, the problem now becomes one of attaining the desired results by the most economical process.

Past experience has shown that it is more convenient to operate at a higher chromic acid concentration than 3% of chromic acid, substantiating the work of R. W. Buzzard [9] mentioned above. A process for regeneration of the chromic acid, already proven in practice, consists of running the tank at a low voltage with lead plates at the anode, with anode-cathode ratio of 1:1. The process is somewhat analogous to the "porous cup" process used in chromium plating for the removal of trivalent chromium.

Glass Insulation

It is more economical in the chromic acid process to use glass insulation than wood. Transite has also been suggested as a substitute and has the advantage over glass in that you can cast your own forms. As to the chemical stability of transite, the only information is by hearsay that it is satisfactory.

Better current characteristics are obtained using glass insulation than when wood is used and very little sludge is formed. The installation is permanent and less chromic acid is reduced to the trivalent condition. The initial cost, about 25 cents per

square foot, is not much higher than for wood. Rough wire glass plate is now being used successfully. Using the wood insulation, it has been noticed that when starting a new solution, the electrolyte seems erratic in its behavior, while with glass, it is more uniform and more reliable for the whole life of the electrolyte.

Ultimate Life of the Solution

In actual operation, the total chromates in the solution have been carried to as high as 40% as CrO_4, at which time the solution had to be thrown out because the chloride content limitation of .02% [5] was exceeded. If free water from chlorides had been used for making up and maintaining the bath, the life of the bath might have been extended even farther. It is believed that when the anode ratio to cathode area is kept at a high value, the solution is self-regenerating with regard to trivalent chromium. Stated in other words, as long as the anodizing bath is kept loaded to its full capacity, the trivalent chromium content is never present in any appreciable amount.

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Here and There

SYRACUSE HAS BEEN GRANTED A TEMPORARY CHARTER BY THE EXECUTIVE BOARD

For several years there has been more or less interest in the organizing of a branch of the American Electroplaters' Society in Syracuse, N. Y., a city of over two hundred thousand population, according to the 1940 Census. Syracuse is a large manufacturing city and should prove to be an ideal place for our organization to expand its activities.

On July 27 a letter was sent to this office signed by ten men, some of whom are Supervisors and foreman platers at the Brown-Lipe-Chapin Company, including our good friend Dwight M. Overcash, a member of Anderson, Indiana, Branch. The letter read as follows: "We the undersigned being engaged in various capacities in the field of electroplating in the city of Syracuse, do hereby petition the National Society for a Charter permitting the establishment of a Branch of the American Electroplaters' Society in Syracuse, N. Y." At present there is a joint affiliation between Binghamton and Syracuse. The distance between the two cities is enough to confine the attendance at the meetings at Cortland to a very small percentage of the membership. This is especially true during the winter months, with the severe storms and snowdrifts to contend with. The fact is, that from November to March very few, if any, meetings are held, because of weather conditions and the inability to get speakers to address the few who in spite of these difficulties feel bound to attend.

It is unfortunate that the two branches are handicapped thus, because we have loyal members in both places. Binghamton-Syracuse Branch has always fulfilled its obligation to the National Society and has cooperated with the various officers in matters pertaining to the welfare of the organization.

A meeting was held in Syracuse on March 28 this year at which time over sixty were present. Those attending were enthusiastic about having regular meetings held in that city, so that the few members from Syracuse (there are 5 out of a total membership of 23) and other prospective members might have the privilege of attending such meetings regularly and receive an incentive to build up the membership there.

Weighing these facts carefully the Board decided to grant Syracuse a temporary Charter, which means organizing its own branch and electing its own officers. The Binghamton members will continue to operate as usual. This seems to be the best way out of a situation that has been a problem for some time. The first meeting of the new branch will be held Sept. 19 at which time the temporary Charter will be presented.

THE FALL OUTING AT LEACREST

The Annual Fall Outing at Leacrest, home of Robert S. Leather, President of the Lea Mfg. Co. will be held on Saturday, October 4. These events are so well known and are so popular with the members of the American Electroplaters' Society and their friends, that a simple announcement is all that is necessary. In connection with the party we have received the following letter written to Bob Leather by Art Logozzo of the General Electric Co., Pittsfield, Mass.

"We will be down to your October picnic with a softball team capable of trimming your 'All-Connecticut Stews,' and if you are afraid to pit them against us, we will play our second team for a work-out.

"Our team will consist of platers from the two General Electric Plants here in Pittsfield, and some of the boys have actually played in fast ball during their heyday."

Will Dr. Young be there, Art?—Ed.

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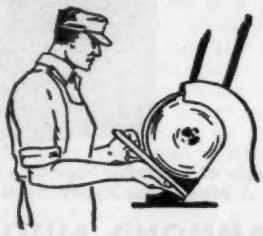

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The Fundamentals *of* Electrochemistry *and* Electrodeposition

II. The Formation of Complex Ions

Ions of the Transitional Elements

By SAMUEL GLASSTONE,
Ph. D., D. Sc.
Frick Chemical Laboratory
Princeton, N. J.

IT was seen in the previous article that the existence of simple ions can be ascribed to the tendency for certain atoms to acquire exceptionally stable structures by the loss or gain of one, two, or sometimes more electrons. Somewhat similar principles apply to the ions of the so-called "transitional elements," that is, chromium, manganese, iron, cobalt, nickel, copper, zinc, cadmium, silver, gold, etc. There is, however, an important difference which must be noted. When an atom of sodium or potassium loses an electron, or magnesium or calcium loses two electrons, the resulting ions have the same electronic arrangement as the highly stable, inert gases. With the transitional elements, however, this is not the case; for reasons which cannot be gone into here, the ions have a structure that is somewhat less stable than that of the inert gases. As a consequence of this incomplete stability ions of the transitional elements are able to combine chemically with neutral molecules and even with other ions, of opposite sign to form more stable "complex ions." These complex ions play an important part in electroplating practice.

Positive Complex Ions

As an example of the formation of a complex ion with a neutral molecule mention may be made of the positively charged, complex copper-ammonia ion resulting from the addition of ammonia (not an ammonium salt) to a solution of a copper (cupric) salt, such as copper sulfate, in water. The ion formed in this manner has a deep blue color and has the formula $Cu(NH_3)_4^{++}$. Silver forms a similar positively charged complex ion, $Ag(NH_3)_2^{+}$,

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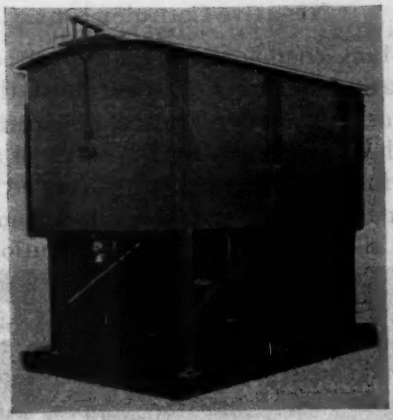

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which is colorless. A special case of complex ion formation involving a neutral molecule, although it is not usually recognized as such, occurs when the neutral molecule is water. For example, the blue copper (cupric) ion in water has, in all probability, the structure $Cu(H_2O)_4^{++}$, which is exactly analogous to that of the copper-ammonia complex ion mentioned above. Similarly, the nickel ion in aqueous solution, formed when a simple nickel salt, such as the sulfate or chloride, is dissolved in water, is $Ni(H_2O)_4^{++}$ or $Ni(H_2O)_6^{++}$, or both may be present. It is not the common practice to regard these ions as complex ions; they are generally called "hydrated ions," although there is probably no fundamental difference between them and such ions as $Ni(NH_3)_4^{++}$ $Co(NH_3)_6^{++}$, and so on. The molecules of water, like those of ammonia, increase the stability of the hydrated ions. It may be noted that many organic bases, which are, in fact, substituted ammonias, are able to form complex ions; some of these are used for the electrodeposition of metals.

Negative Complex Ions: Complex Cyanides

Many complex ions are formed between metal ions and the negatively charged cyanide ions; the resulting complexes are almost invariably negatively charged. One of the best known of these ions is the silver-cyanide, or argentocyanide, ion, having the formula $Ag(CN)_2^-$. It is formed when an excess of a soluble cyanide salt, such as potassium cyanide, is added to a solution of a silver salt. The cyanide solution provides CN^- ions, while the silver salt contributes Ag^+ ions, probably in the hydrated form; the reaction $(Ag^+ + 2CN^- = Ag(CN)_2^-$ then occurs with the formation of the highly stable, negatively charged argentocyanide ions. Complex cyanide ions are familiar to electroplaters. There are the copper (cuprous) cyanide ions, $Cu(CN)_2$ and $Cu(CN)_3^{--}$, and possibly others, and the cadmium cyanide ions, $Cd(CN)_3^-$ and $Cd(CN)_4^{--}$, which, like the silver ions, are employed in plating the respective metals. Besides the cyanide ions, other negative ions, such as thio-sulfate, and the ions of organic acids, particularly citrates and tartrates, are often employed to form complex ions of certain metals. The solutions of complex ions such as these have also found some application, at various times, in the electrodeposition of metals.

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Equilibria of Simple and Complex Ions

In solution every complex ion is in equilibrium with a certain proportion of the simple ions of which it is composed. Consider, for example, the argentocyanide ion, $Ag(CN)_2^-$, formed from Ag^+ and CN^- ions; in a solution of argentocyanide ions there are a few free simple ions, and the equilibrium may be represented by a double arrow, thus $Ag(CN)_2^- \rightleftharpoons Ag^+ + 2CN^-$.

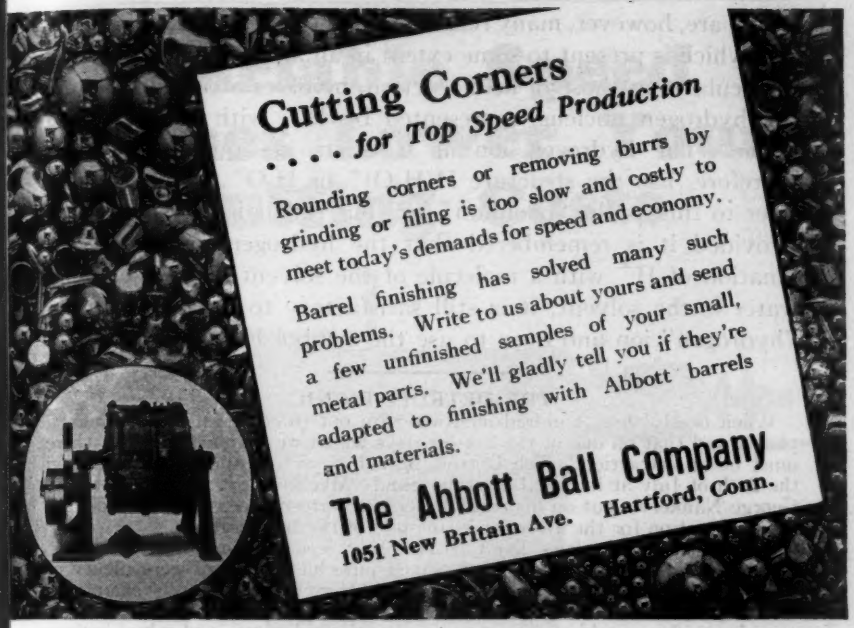
In this particular instance the concentration of the simple ions is very small, and so the complex ion is said to be highly stable. An extreme case of stability is provided by the ferrocyanide ion, $Fe(CN)_6^{----}$; a solution of potassium ferrocyanide contains so few simple ions of the metal iron that it shows none of the reactions of the latter. Although silver can be obtained by the electrolysis of an aqueous solution of argento-cyanide ions, it has not been found possible to obtain iron in this manner from ferrocyanide ions.

Other Negative Ions

Many familiar negative ions, such as carbonate, CO_3^{--}, nitrate, NO_3^-, cyanide, CN^-, and hydroxide, OH^-, ions, may be regarded as complex ions of a relatively simple type. In each case, the so-called "central atom," e.g., carbon, nitrogen or oxygen, cannot, with ease, acquire of its own the electronic arrangement characteristic of an inert gas. It overcomes this difficulty by sharing electrons with one or more atoms of another element, e.g., the nitrogen atom shares with three oxygen atoms, and the whole system, such as NO_3, then gains an electron to form the highly stable electronic arrangement present in the nitrate ion, NO_3^-. The corresponding grouping involving carbon and oxygen must gain two electrons to form the stable carbonate ion, CO_3^{--}. The fundamental principles involved in the formation of these ions are not essentially different from those operating in the cases already considered.

The Hydrogen Ion

An example of special interest is provided by the hydrogen ion. The atom of hydrogen consists of a nucleus and *one* electron; if that one electron were lost, in the formation of a hydrogen ion, the resulting system would be a "bare" nucleus.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There are, however, many reasons for believing that the hydrogen ion, which is present to some extent in all aqueous solutions, and particularly in those of acid reaction, involves a combination of the hydrogen nucleus, represented by H^+, with a molecule of water. The hydrogen ion as it exists in aqueous solution, therefore, has the structure $H(H_2O)^+$ or H_3O^+. Some writers refer to this as the "oxonium" ion, but this is hardly necessary. Provided it is remembered that the hydrogen ion is a combination of H^+ with a molecule of the solvent, e.g., H_2O when water is the solvent, it is still satisfactory to speak of it as a "hydrogen" ion and even to use the symbol H^+.

THE DETROIT PICNIC

When nearly three hundred men will turn out to come to, of all things, a picnic, and that on one of the hottest days which we ever experienced, there must be an attraction. The Detroit Branch gave its annual stag picnic on the 26th of July at its usual location, Sandy Mac's. Boy, it was a hot day. George Nankervis put on his regular efficient performance, which is probably the explanation for the attendance, in spite of the temperature.

Of course a lot of softies, like Carl Huessner, Red Wilson and Mose Cherry just sat around inside all day and played pinochle but there were plenty of others who, just between you and me, should have had their sanity examined, who went out in that hot sun and engaged in various forms of contest. There were horse-shoe pitching eliminations, three-legged races, and wheel-barrow races. There were golf-playing contests and golf driving contests. In these latter, George had the brilliant idea of dividing up the groups between those under 36 years old and those over, and having separate contests. We are still trying to figure out, what good it would have done us to compete against ancient gentlemen of 36, instead of young ones of 24, had we been silly enough to have gone out in that hot sun and batted a ball around, which praise Heaven, we are not yet sufficiently senile to do. Walter Pinner and Chalkie Slacks came in off the golf course with their faces resembling newly-pickled beets and tried to impress us with what a good time they had been having. We did not impress.

At noon there was corn on the cob, hot dog and steak sandwiches, all cooked in the open before you. Naturally the liquid refreshment counter worked pretty fast that day, but it probably caused a lot of old-timers to turn over in their graves, if they knew the percentage of soft drinks which were consumed with free beer available. Apparently it was even too hot for beer with many people. In the afternoon, George had paid the Boys Club of Detroit, which is a chartiable institution, for boys' welfare, to put on a series of boxing and wrestling matches. There was a full-sized ring on a platform, with ropes and everything, and the kids certainly went to it. They made up in zeal what they lacked in science, and it was lots of fun.

Eventually they dragged our revered national secretary, Bill Kennedy, out into that broiling hot sun to stand up on the platform and pick out countless numbers for the distribution of door-prizes, while we sat under cover in the shade and laughed. We could not help thinking that while honesty may be its own reward, that a reputation for being honest sometimes has disadvantages. At last, they went home to tell their wives what a swell time they had been having. If they had been home, they would have been grouching all day to those same wives because of the heat, but out there they were just 300 little boys out on a picnic. Have we mentioned before, that it really was a hot day!

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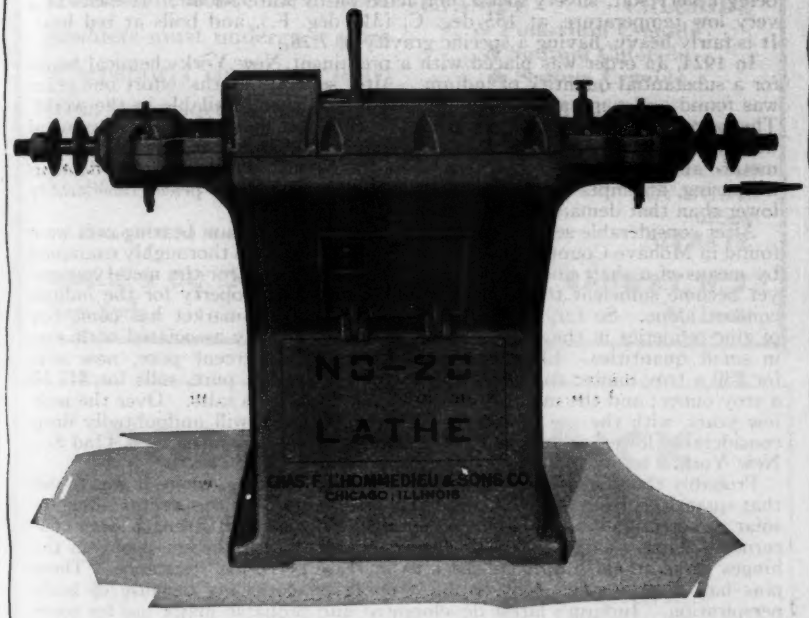

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Indium

Reprinted from *The Iron Age*, December 19, 1940 with the compliments of Indium Corp. of America, 60 E. 42nd St., New York, N. Y.

By J. R. DYER, JR.
Technical Director, Indium Corp. of America

Indium, so named because of its indigo spectrum, has been since only the past few years a rare metallic element following its discovery in 1863 by Reich and Richter. Indium belongs to the aluminum group as regards properties, being a very soft, silvery metal, not acted on by water or air. It melts at a very low temperature, at 155 deg. C. (311 deg. F.), and boils at red heat. It is fairly heavy, having a specific gravity of 7.28.

In 1924, an order was placed with a prominent New York chemical house for a substantial quantity of indium. After several months' effort one gram was found and purchased, it being all that was then available in the world. The price was $10 a gram, considerably higher than platinum. The metal was found to be particularly valuable as a stabilizer for certain non-ferrous metals, and uses in other directions were indicated. Therefore, with demand increasing, attempts were made to secure quantities at a price considerably lower than that demanded for the first gram.

After considerable searching, sizable quantities of indium bearing ores were found in Mohave County, Arizona, and the property was thoroughly examined by means of a shaft and driftings. However, demand for the metal has not yet become sufficient to justify exploitation of this property for the indium content alone. So far, the indium coming onto the market has come out of zinc refineries in the same area, as indium is usually associated with zinc in small quantities. Electrolytic indium, 99.99+ percent pure, now sells for $30 a troy ounce; commercial indium 98+ percent pure, sells for $12.50 a troy ounce; and the metal is also available in various salts. Over the next few years, with the use of indium growing, the price will undoubtedly drop considerably lower, according to Indium Corp. of America, 60 East 42nd St., New York.

Probably the first use of indium was in dental castings, where it was found that quantities from 0.5 to 5 percent greatly improved the dental alloy insofar as corrosion resistance, melting range, hardness and strength were concerned. Next, a large optical company indium treated the small pins in the hinges of spectacle frames in order to increase corrosion resistance. These pins had always given considerable trouble by corroding because of body perspiration. Indium's latest development and probable major use for some time to come is protection against wear and corrosion in internal combustion engines, particularly for the bearings. It has been particularly effective in the airplane engine field, and only lately the White Motor Co. has advertised indium treated bearings, of the aviation type—copper, lead bearings impregnated with indium to prevent deterioration due to acid condition in the oil. The metal indium is also showing excellent experimental results in the electrical contact field as well as in the field of low melting alloys.

Indium, used to protect metals against corrosion and wear, is usually plated onto a base metal, and then diffused or alloyed to the surface by a low temperature treatment.

The patented procedure used with complete success in the indium plating of metal pieces is as follows:

Racking: The pieces to be plated are racked in a suitable manner so that the back of the piece is protected. This may be done by employing a rubber band or a rubber sleeve into which the pieces are slipped, good contact being made with the cathode wire on the back of the pieces by the pressure of the rubber band. That part of the band, if used, which stretches across the face of the piece will not produce an appreciable amount of shielding action—the bath has exceptional throwing power.

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Cleaning: The racked pieces then are immersed in a hot alkaline electrolytic cleaning bath for 10 to 20 sec., made the cathode, and sufficient current (10 amp. per sq. ft.) is applied to give a good evolution of gas over the surface. When clean the pieces are removed and rinsed twice in running water; the first rinse is preferably warm water, and second rinse cold water. The pieces are now ready to be plated with indium.

The composition of the alkaline electrolytic cleaning solution may vary to suit requirements, i.e. greasy articles require a more concentrated solution. However, no matter what cleaning method is used, the article to be plated must be clean and free from "water break." A suggested formula for the cleaning procedure is as follows:

8 oz. of sodium carbonate (or tri-sodium phosphate).
2 oz. of sodium hydroxide.
1 gal. of water.
90 to 100 deg. C. (194 to 212 deg. F.) operating temperature.
1 oz. of sodium cyanide may be added to remove stain.

Plating: The pieces now are plated with indium by immersing them in an indium cyanide plating bath and using a current density of 0.1 to 1.0 amp. per sq. in. The time required, of course, depends on the rate of deposition of the bath and the amount of indium required for the protection of the pieces.

The indium cyanide plating bath consists essentially of the following for 1 gal. of plating solution:

4 oz. troy of indium (as chloride).
2 oz. of dextrose.
12 oz. of sodium cyanide.

Making of bath: To make the indium chloride solution for a 1 gal. bath as an example, 4 oz. of indium metal are cut into small pieces and converted to the chloride by dissolving in CP HCl of sp. gr. 1.16. About 15 to 20 oz. of the acid will be required to put the metal into solution, and gentle heat is applied to effect solution of the last pieces of metal. The solution of indium chloride ($InCl_3$) is now heated to volatilize any excess acid, or, until the surface of the solution is slightly encrusted. Care should be taken to see that the solution does not "freeze" by being heated too long or allowed to cool without dilution. The encrusted solution is now diluted with distilled water to a volume of 500 c.c. This solution is called the stock indium chloride solution. Stock indium chloride solution may be purchased as indium trichloride in solution—one fluid ounce containing one ounce $InCl_3$. One 8-oz. bottle of this solution is generally used to make 1 gal. of plating solution.

Two ounces of dextrose (No. 84 Eastman or Merk's USP or equivalent quality) are dissolved in as little water as possible. Slight heating may be used to hasten solution and, if used, the solution is allowed to cool before using. Then, 12 oz. of sodium cyanide are dissolved in as little water as possible, approximately 750 c.c. by means of a solution cone, and when all the cyanide has dissolved, the dextrose solution is poured into the cyanide solution. The resulting solution is known as the sodium cyanide-dextrose solution.

The indium chloride solution is now added, in small portions, with constant stirring, to the cyanide-dextrose solution. This operation should only be carried out in a good fume-hood, or other well ventilated place, owing to the generation of *dangerous fumes*. As the small portions of indium chloride solution are added a precipitate forms which dissolves on stirring. Under no conditions should more chloride solution be added until this precipitate is dissolved. However, the solution of this precipitate should take place almost immediately and no permanent precipitate should exist at this point. All the chloride solution should be added in this manner to the cyanide-dextrose solution and the resulting solution diluted to about 2 liters or ½ gal. with distilled water. This concentrated plating solution should be allowed to stand at least 48 hr. or longer, if possible, before using to make the final bath.

After the concentrated solution has aged for 48 hr. or longer, it will be found to have turned from a straw color to dark brown. Also, a dark carbon-like precipitate will be found to have settled out. This precipitate should not be

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gelatinous or of considerable volume and may readily be filtered off. The solution is now filtered, by suction through a Buchner funnel for speed, using a Whatman No. 54 filter paper, into the plating tank and diluted to 1 gal with distilled water. An analysis for free cyanide should be made at this point, and it will be found that the free cyanide will be one-third to one-half of the required bath composition, as stated above. Sufficient sodium cyanide should, therefore, be added to bring the free cyanide content of the final bath to 12 oz., or at least 100 gm. per liter. The plating bath is now ready for use.

Operation: To operate the bath an insoluble anode is used, such as carbon or platinum, etc., and a current density high enough to give gassing at the cathode (.01 to 1.0 amp. per sq. in.). The resulting plate or deposit is soft, gray and matte-like in appearance.

Rate of Deposition: The rate of deposition of the bath is determined by plating a weighed cathode for a definite length of time at a current density which is expected will be used for operation. The rate of deposition may readily be calculated from these data. It will be found that the rate of deposition of a new bath will run in the neighborhood of 15 mg. per amp.-min., and that as the bath is used or ages the rate of deposition gradually falls off until at about 5 to 8 mg. per amp.-min. it remains fairly constant. Depletion of metal in the bath or of free cyanide may still lower the rate of deposition, at which time additions should be made to maintain the efficiency of the bath.

Maintenance: Since insoluble anodes are used, all metal plated is from the bath, and must be replaced by addition to the bath. Analysis of the bath and/or a record of the plating will show when these additions are necessary. If additions are necessary, they are prepared, in the required concentrations, as in the original preparation of the bath, and are added to the bath in the concentrated solution after filtering but not diluting.

The cyanide content should not be allowed to fall below 11 oz. per gal., or 90 gm. per liter, and preferably maintained at 11 to 13 oz. per gal., or 90 to 100 gm. per liter. The indium content should not fall below 3 oz. per gal. for consistent plating results.

Analyses: The method of determining the amount of free cyanide in the bath is the same as that for a silver plating bath (by means of silver nitrate), with the possible exception that the sample should be diluted to several times its volume in order that the color will not obscure the end point.

The indium content is determined by breaking up a sample of the bath with aqua regia; precipitating the indium as hydroxide with ammonium hydroxide; filtering; washing the precipitate with ammonia water until nice and white; the igniting of In_2O_3 over a moderate flame; and from the weight of oxide, calculating the amount of indium. A careful record of the analyses, additions and rate of deposition should be kept.

Diffusion: The plated pieces are removed from the plating bath and given several water rinses. The first rinse should be hot, and should be retained as it will contain considerable drag-out, the final rinse should be in clean hot water. The pieces are now ready for diffusion.

Diffusion means heating the plated pieces to a temperature above the melting point of indium and maintaining that temperature long enough to permit the indium to diffuse throughout the base metal. This may be accomplished by means of an oil bath or an oven under an inert atmosphere or having no air circulation. Indium as plated is very soft; after diffusion it will be found to have hardened, or actually to have alloyed with the base metal.

The time of diffusion employed with success and without danger of weakening the bond on steel-backed type pieces, is 2 hr. at 340 deg. F. The pieces are permitted to cool slowly and are ready for use without further treatment.

Engine Bearing Tests

As already mentioned a major use of indium, plated and diffused as described herein, is in the protection of engine bearings. Modern engines have high bearing loads and elevated operating temperatures. These conditions have caused engine manufacturers to turn from those bearings having low

NO ABSTRACTS

Owing to the shortage of branch meetings during the summer months when meetings were suspended, we have used all our abstracts. These are very much sought after for the information they contain. Those who have contributed to the Abstract Section, and others who would like to, are requested to send us articles of interest for publication.

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fatigue value to those alloys which have greater strength and wear, such as cadmium alloys, lead alloys, copper-lead alloys and cadmium-nickel alloys. Unfortunately these alloys are susceptible to corrosion in the presence of lubricants containing organic acids. These acids may have been derived from additions of animal or vegetable oils, or by oxidation of some petroleum oils under operating conditions.

Additions of fractional percentages of indium metal to bearings in the finished-machine state, as reported by C. F. Smart in a paper presented before the A.I.M.E., showed the beneficial effects of the addition of indium in laboratory beaker corrosion tests, by bearing tests and by engine tests. Comparative tests by one of the major oil companies confirm his conclusion.

In one engine test, connecting rod bearings lined with cadmium-silver-copper alloy, treated with approximately 0.20 percent indium, were rund for over 5000 miles at high speed. At the conclusion of the test these bearings showed only slight evidence of etching, whereas untreated bearings run in one of the connecting rods were replaced three times, because of their badly corroded condition. The acid number of the oil used reached a value of 3.3.

In another engine the fatigue life of babbitt-lined bearings ranged up to a maximum of about 60 hr. under the severe conditions used for testing (4250 r.p.m., full throttle, with oil temperature 250 deg. to 260 deg. F. at the bearings). Cadmium-silver-copper bearings treated with 0.4 to 0.5 percent indium run under these test conditions, and in the presence of oil containing 0.5 percent of oleic acid, were in excellent condition after 120 hrs., showing no evidence of corrosion and very slight indication of fatigue cracks.

Such tests on bearings, in engines run at high speed and with corrosive oils verify the information obtained from laboratory tests—namely that the indium treatment as described prevented corrosion of the cadmium-alloy bearings without impairing the fatigue resistance or other bearing-metal properties.

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JUDSON R. ELSTER, *Secretary.*

A WARNING

The Detroit Branch will hold its annual Educational Session and Dinner-Dance at the Hotel Statler, Saturday, December 6, 1941. The party will be up to the usual standard of these affairs and the Educational Session will be headlined by Mr. Cameron of the Ford Motor Company whom you have probably heard over the radio.

The Detroit Branch wants and welcomes attendance from other branches. However, the popularity of the party is such that probably several times the number of tickets could be sold as there are seats at the dinner-dance. The result is that restrictions on the sale of tickets is necessitated. Sales are limited to members of the American Electroplaters' Society in good standing and to advertisers.

Any member of any branch other than Detroit may buy one or two tickets prior to November 1, but they must be used by himself and other members of his family. In case of change of plans, any tickets would be refunded which reach Detroit through December 5th. Applications must be made on forms now in the hands of all branch secretaries.

The Detroit Branch hopes for a good attendance from other branches.

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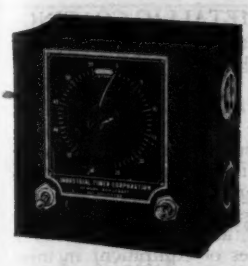

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RECENT DEVELOPMENTS IN PROTECTIVE METALLIC COATINGS

(From a paper by Dr. R. M. Burns, Assistant Chemical Director, Bell Telephone Laboratories, New York, before Ontario Chapter, American Society for Metals, Toronto, March 1, 1940.)

In view of the fact that losses from corrosion on the North American continent are estimated to be over one billion dollars per year, it might seem that methods of protection are not very effective. The truth of the matter is that the loss would be immeasurably greater were it not for the splendid progress that has been made in the field of protective coatings.

The two general divisions in the practice of corrosion prevention are:

1. The provision of a non-corrosive environment, as in the de-aeration of boiler-feed waters, and the operation of certain types of equipment in inert atmospheres.

2. The interposing of a protective film to exclude the corrosive environment from the metal. These protective films may be divided into two main classes, the first consisting of those films formed naturally through the production of corrosion products on the surface of the metal to give a thin protective coating; and the second, comprising films of paints or varnish, ceramic products or metals which are applied by various means.

A modified branch of the natural type of protective coating is the chemical conversion coating produced by various treatments on different types of metal. Familiar examples are the phosphate films formed on steel by pickling in phosphoric acid, and the anodic oxidation of aluminum, usually in sulphuric acid, to produce an abrasion resistant surface that may be modified by time of treatment and other factors, and is easily dyed to give attractive color effects.

In the production of good metallic coatings, surface preparation is a matter of prime importance. It has been said that the character of a coating is no better than that of the surface to which it is applied. With this in mind, steel producers and users have taken steps to improve the basic materials. Steel stocks are produced free from blemishes and in subsequent operations the quality of the material is maintained by careful handling, the use of controlled atmosphere in heat treatment, pickling with the aid of inhibitors, and adequate neutralization.

Degreasing with chlorinated solvents has also contributed to the preparation of metal surfaces in better condition for plating operations. Electrolytic alkali cleaning operations are also used to advantage, equipment being available for the cleaning of strip at speeds of 900 to 1800 feet per minute. Brass is cathodically cleaned in sulphuric acid. Anodic polishing operations, introduced some ten years ago to produce bright smooth surfaces for certain equipment in the rubber tire industry, is being more generally applied.

Metallic Coatings

Zinc is the most important of the metallic coatings, and forty-five percent of the metal consumed in the United States is used in the production of zinc coatings.

In the hot galvanizing of steel, a notable advance is the use, in some instances, of an oxidation-reduction treatment in the preparation of the steel. In this way, the steel surface is improved for the application of zinc by hot dipping.

The addition of aluminum to zinc in galvanizing results in the reduction of the thickness of the alloy layer between the iron and the zinc coating. The use of tin in zinc for galvanizing, in amounts greater than one-half percent, leads to the acceleration of atmospheric corrosion.

Electroplated zinc deposits have the advantage of being applicable in greater thicknesses than hot dipped coatings, and electroplating methods are making progress, particularly in the wire field, with the speeding up of plating rates as much as twenty-five fold. Plants have already been installed, one utilizing over 200,000 amperes with a capacity of hundreds of tons of wire per day.

FILTERS for

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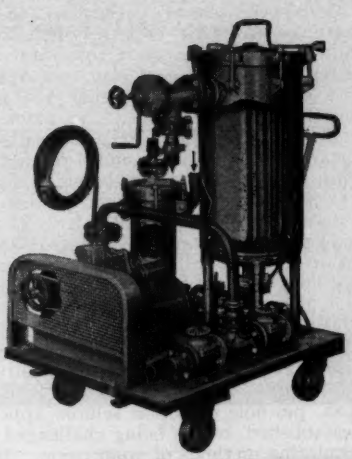
- ***Chrome***
- ***Copper Sulphate***
- ***Brass***
- ***Cyanide Copper***
- ***Brite Zinc***
- ***Silver***
- ***Electrocolor***
- ***And Others***



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With the increasing importance of appearance in countless types of metal products, zinc protective coatings are keeping pace with the rest through the development of methods for bright plating with the metal.

The protective value of zinc depends directly upon the thickness of the coating, except in sprayed coatings. Experiments have listed environments in order of increasing attack as follows: rural, tropic marine, temperate marine, suburban, urban, highly industrial. The resistance of zinc coatings to corrosion under water depends largely upon the degree of circulation of the water, and its oxygen content. When a zinc-coated cable is lapped with jute to stagnate the water, the capacity of the zinc to resist corrosion is increased.

Cadmium plate has good color and is very satisfactory for indoor use, but does not possess corrosion resistance equal to zinc under conditions of outdoor exposure. Bright nickel plate for use under chromium, etc., may be produced without buffing by the use of various addition agents. One type of bright nickel plating bath contains 1 percent cobalt and formaldhyde. An important development in nickel plating is the use of heavy coatings to build up worn parts, such deposits being appliable with various degrees of hardness.

A very promising process of protecting metal, known as "Corronizing," consists of the application of a layer of nickel plate, followed by zinc or tin. Heating to a temperature of 700 to 1000°F. results in the formation of a zinc-nickel or tin-nickel alloy which is practically free from pores, and which secures a very high rating on the salt spray test. There is somewhat more porosity in the tin-nickel coatings than in the zinc-nickel plate, but they have possibilities in the food industries. The success of this method depends largely upon the production costs that may be attained in practice.

Seventy percent of the production of tin plate is used in cans. Tin does not protect iron very efficiently in the air, but under the conditions existing in the can, pin-hole corrosion seldom appears. The hot dip process is old and well established, but is being challenged by continuous rolling processes and electroplating methods of application. Both alkaline and acid baths are used in tin plating, the former giving coatings of lower porosity at an efficiency of only 30 or 40 percent, while the latter gives an efficiency of 90 to 95 percent, and permits the use of higher current densities.

Aluminum is used to some extent for the protection of steel, the coating being in the form of an aluminum-rich alloy layer, formed by heating the steel part packed in aluminum. Aluminum cladding is also employed for the protection of many of the more corrodable aluminum alloys. An aluminum dip process for protection of iron consists in heating iron to 900°F., and dipping it in slightly cooler aluminum, all in a hydrogen atmosphere.

The good properties of lead cannot be generally utilized because it does not wet steel, but heavy lead sheet burned on is excellent, if expensive, protection in certain applications.

Silver plate has prospects for the canning industry, but to date it has not been possible to combine the thinness of film dictated by costs, with the freedom from porosity demanded for adequate protection.

It will be seen from this review that progress in protection of metals by coatings of other metals is largely in the direction of electroplating methods and continuous processes. Further savings are being effected by the production of parts in special plating baths so that no further finishing is required.

STETTINIUS PROHIBITS MAKING OF WHITE SIDEWALL TIRES

(From *Defense*, Aug. 12, 1941.)

The manufacture of white sidewall automobile tires was prohibited August 8 in an order signed by Priorities Director Stettinius.

The order takes effect at midnight, August 23, 1941.

It is estimated that cessation of white sidewall tire manufacture will save more than 6,000 tons of crude rubber a year, or over 13,000,000 pounds.

Manufacture of white-wall tires consumes approximately two pounds more crude rubber per tire.

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COURSES OFFERED TO AID WORKERS IN DEFENSE INDUSTRIES

COURSES IN ELECTROPLATING

The Institute of Electrochemistry and Metallurgy, 59-61 East Fourth Street, New York City, will offer specialized courses in the field of electroplating and metallurgy during 1941-42. Registration will be held for the Fall term from September 15th to September 19th, and the first class meeting will take place on September 23. The following studies will be offered:

FALL COURSES

Electroplating I. The course is designed to give the electroplater or industrial worker a foundation in chemistry including qualitative and quantitative analysis. One hour each evening will be devoted to class lectures in which will be discussed the theories of modern chemistry as applied to electroplating. The remaining hours will be devoted to the laboratory where the student will conduct his own experiments. Tuesday and Wednesday from 7:30 to 11:00 P. M. Dr. Young and Mr. Klinsevich. Fee, $45.00.

Metallurgy I. The student will be introduced to the structure of metals and alloys and factors are taken into account which affect these, such as temperature, mechanical working, etc. The application of the phase rule to physical metallurgy will be discussed. Both binary and tertiary systems will be studied and illustrated. Heat treating, surface treating and testing of metals and alloys will be studied. Tuesday and Wednesday, 8:30 — 9:30 P. M. Dr. Young and Mr. Klinsevich. Fee $30.00.

Research I. This course is designed to give the practical electrochemist a chance to investigate problems in his field. One half hour per week is devoted to a conference with the instructor in which the method of attack is laid out. The remaining time is spent in the laboratory where the student applies his knowledge and technique to the solving of problems which arise in such an investigation. Tuesday and Wednesday, 7:00 — 11:00 P. M. Dr. Young. Fee $30.00.

Industrial Microscopy IA. This course is specially planned in photomicrographical analysis, general microscopy, and instruction on the metallographic microscope. Subjects covered include the preparation of materials and the proper selection of optical equipment, methods of illumination, control of glare, illumination by incident light, and the use of color filters, special methods of particle-size determination, determination of refractive index, micrometry, and the proper use of mounting media with respect to its relative refractive index. Work with the polarizing microscope may also be arranged. Mr. Shillaber. Tuition and laboratory fees, $55.00. Hours to be arranged and announced later.

Time payments may be arranged if desired. For further information call Dr. C. B. F. Young, ORchard 4-1778 or Flushing 9-1685.

For men outside the N. Y. area a course in electroplating by correspondence has been written. For further information write to Dr. C. B. F. Young, Box 292, Flushing, N. Y.

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QUINHYDRONE pH METER

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Check these improvements:

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G. & N. SEEKS REGULATION

The G & N Manufacturing Company of Cleveland, maker of die-casting machinery, has launched a campaign for mandatory standardization of valves used on industrial nitrogen bottles. This action grew out of an explosion which occurred in a Cleveland diecasting plant August 13, killing three men and injuring a fourth. The explosion occurred after the accumulator tank on a diecasting machine had accidentally been filled with oxygen instead of the nitrogen which had been intended for it.

The oxygen came into contact, under pressure, with hydraulic fluid used in operation of the machine, and a chemical reaction was set up which caused the oil to ignite and burn at tremendous speed. Directly responsible for this disaster was the fact that it was possible for a workman to release oxygen into the accumulator tank of the machine. If the valve on the oxygen bottle had made the transfer impossible, the mistake could not have been made.

G & N seeks to have the U. S. Bureau of Standards introduce a regulation making it necessary for nitrogen producers to sell nitrogen only in bottles with left-hand threads on the valve fittings. If this is done, all nitrogen inlets will have corresponding threads and it will be impossible to attach them to an oxygen bottle. The danger of explosion through the contact of oxygen and oil is not limited to the diecasting industry. In the utility industry, for instance, both oil and nitrogen are used in contact with each other in certain types of generators, and were oxygen accidentally substituted for nitrogen an explosion would occur.

Similarly, some oil-filled power transmission cables are now being emptied of oil and filled with nitrogen, and here again if oxygen were substituted the oil would explode with disastrous results. The appeal for action in this matter has been made to the International Acetylene Association and to the U.S. Bureau of Standards, and these two organizations have taken it under consideration.

SCRAP — GREAT 3-POINT LESSON

(From *Steel*, July 28, 1941.)

This nation has arrived at a point in its defense program where it should begin to profit from past mistakes.

One good place to begin is its handling of the problem of iron and steel scrap.

Today the scrap situation is serious. Production in steelworks and foundries is on the point of being throttled because of the difficulty of obtaining adequate supplies.

Why has this condition been permitted to develop?

To answer this question dispassionately, and without intent to criticize, one must go back to the period immediately before the European war broke out.

At that time the demand for steelmaking scrap in the United States was sluggish. As domestic steelmakers did not seem to want scrap at any price, many dealers turned to the export markets.

Exports of scrap in the four years from 1936 to 1939, inclusive, totaled 14,127,343 net tons.

More than half of this scrap—7,143,118 tons—went to Japan alone. Italy received 1,710,389 tons and Spain 39,872 tons. The three nations imported 8,893,379 net tons of American scrap—a substantial contribution to the preparation of the axis war machine.

War broke out in September, 1939. One would expect that this would have caused an immediate curtailment of scrap shipments to axis belligerents. But in 1940 the United States shipped 1,556,300 tons of scrap to axis powers and to nations under axis control as against 1,541,255 tons to England and her allies.

With the proper foresight we could have retained at least 6,000,000 tons of the more than 10,000,000 tons of scrap which we turned over to potential enemies from 1936 to 1940.

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80TH MEETING OF THE ELECTROCHEMICAL SOCIETY, INC.
HOTEL KNICKERBOCKER, CHICAGO, ILLINOIS
OCTOBER 1-2-3-4, 1941

Industrial Electrochemical and Educational Exhibits will be open to all attending throughout the meeting. The Oceanic Room, on the Convention Floor, has been reserved exclusively for these exhibits.

LADIES PROGRAM. The Ladies will find Chicago hospitable and the Ladies' program just what they might hope for.

Thursday, October 2nd — A. M.

Electroplating Technical Session — Four Papers:

1. General Principles and Methods of Electroplating, *Blum*, *Beckman*, and *Meyer*
2. Alloy Plating, *Faust*
3. Rare Metal Plating, *Kushner*
4. Lead Plating, *Blum*

Friday, October 3rd — P. M.

Electroplating Technical Session — Six Papers:

1. Acid Zinc Plating, *Lyons*
2. Cyanide Zinc Plating, *Hull* and *Wernlund*
3. Cadmium Plating, *Westbrook* and *Soderberg*
4. Brass and Bronze Plating, *Coats*
5. Silver Plating, *Promisel* and *Wood*
6. Iron Plating, *Thomas*

Saturday, October 4th — P. M.

Electroplating Technical Session — Seven Papers:

1. Rochelle Copper Plating, *Graham* and *Read*
2. High Speed Copper Plating, *Wernlund*
3. Acid Copper Plating, *Winkler*
4. Nickel Plating, *Pinner*, *Soderberg*, and *Baker*
5. Chromium Plating, *Dubpernell*
6. Alkaline Tin Plating, *Oplinger* and *Bauch*
7. Acid Tin Plating, *Pine*

(Many other technical papers will be read but the above papers are published for the benefit of A.E.S. members.—Ed.)

THE QUESTION BOX

Lately we have been donating a separate page to the "Questions and Answers" appearing in the various reports from the Branches. This is an important item in the REVIEW and is eagerly scanned by our readers. In the July issue, the question was asked, "What is a good brightener for a cyanide zinc bath?" The answer: "Mercury Oxide or Sodium Chromate." A member writes regarding the answer given:

"It is true that mercury oxide will act as a brightening agent in a zinc cyanide cleaning bath finding a white brightness rather than a mirror brightness. The answer further includes sodium chromate for cyanide zinc plating.

"It is apparent that the person answering this question obtained a brightening effect with the addition of sodium chromate but that brightening effect was due to the reduction of efficiency of the plating and instead of obtaining a heavy deposit which would be normal under the plating conditions used, the zinc cyanide bath was only yielding a strike zinc plate. This strike was undoubtedly very thin which accounted for its apparent brightness.

"This condition has come up in a number of plants which were using chromic acid as a bright dip following zinc or cadmium plating. Now if the chromic acid were dragged back through the cycle and eventually found its way into the zinc or cadmium plating solution, there was a resulting decrease in the efficiency of the plating solution.

"We feel that the readers of the REVIEW should be in some way informed of the true conditions and the resulting difficulties met when sodium chromate or any hexavalent chromium be introduced by accident to the cyanide plating solution."